Material, psychosocial, behavioural and biomedical factors in the explanation of socio-economic inequalities in mortality: evidence from the HUNT study

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Summary

Background: Previous studies have assessed the relative importance of material, psychosocial and behavioural factors in the explanation of socio-economic inequalities in mortality, but research into the contribution of biomedical factors has been limited. Our study examines the relative contribution of (1) material, (2) psychosocial, (3) behavioural *and* (4) biomedical factors in the explanation of socio-economic (educational and income) inequalities in mortality.

Methods: Norwegian cross-sectional study HUNT 2 based on a total county population was linked to mortality data (1995/97 – 2003). In this analysis, 18 247 men and 18 278 women aged 24-80 without severe chronic disease at baseline were eligible.

Results: No socio-economic inequalities in mortality among women were found. In men educational and income related inequalities in mortality were found with a relative risk for the lowest educational group of 1.67 (1.29 to 2.15) and the lowest income quartile of 2.03 (1.57 to 2.70). Together, the four explanatory factors reduced the relative risk of mortality of the lowest educational group to 1.18 (0.90 to1.55) and the relative risk of mortality in the lowest income quartile was attenuated to 1.17 (0.83 to 1.64). Known biomedical factors contributed least to both educational and income inequalities in mortality.

Conclusions: Material factors were the most important in explaining income inequalities in mortality amongst men whilst psychosocial and behavioural factors were the most important in explaining educational inequalities. This suggests that improving the material, psychosocial and behavioural circumstances of men might bring more substantial reductions in socio-economic inequalities in mortality.

Summary word count: 246

INTRODUCTION

Many studies have shown a social gradient in mortality with higher mortality rates in lower socio-economic groups [1]. Various theoretical explanations of the pathways and mechanisms underlying this inequality have been developed [1-3]. The main explanations give primacy to material, behavioural or psychosocial factors (Box 1). However, these factors appear to both independently influence the social gradient in mortality, whilst also being interrelated to one another. They may also account for different aspects of social inequalities in health at different stages (the lifecourse approach[2] – Box 1). Therefore, several empirical studies have been undertaken to establish the relative importance of each of these factors [4-8]. These studies, which have utilised either education or income as measures of socio-economic status, found that material factors account for the largest amount of educational inequalities in health[7 8] whereas a vigorous discussion has developed as to whether income inequalities in health are mainly due to an uneven distribution in access to resources [5] or due to psychosocial perceptions of these inequalities [6]. The contribution of behavioural factors has varied somewhat across studies [9 10].

In addition to these social factors, biomedical factors represent another possible explanation of inequalities in mortality (Box 1). For example, studies have found associations between low socioeconomic position (SEP) and higher prevalence of biomedical risk factors such as obesity, high blood pressure, glucose intolerance etc. – [11 12] Except for some external causes of death, health effects of material, psychosocial and behavioural factors work through biological mechanisms. In previous research, biomedical factors have mainly been studied separately, or in relation to one or more social factors [12]. Little attention has been paid to what role biomedical factors play in addition to social factors and how they might contribute to inequalities in mortality [4 11]. If we had sufficient information on biological processes leading

to mortality, biological factors would perhaps explain a large proportion of SE differentials in mortality. However, based on available data, only known biomedical factors are being employed.

In this study we therefore add known biomedical factors into the explanatory model of income and educational inequalities in mortality presented by van Oort and colleagues [8] (Figure 1), thereby developing the following conceptual framework: material factors might affect health inequalities directly or indirectly through psychosocial, behavioural or biomedical factors; psychosocial factors might work directly, or indirectly through behavioural or through biomedical factors; behavioural factors may be either direct or indirect via an interplay with biomedical factors. The direction of causality is two-way, as for example biomedical factors can also affect material factors (e.g. making unemployment more or less likely), however the direction from material factors through behavioural is more probable than the other way around [7].

Our exploratory study aims to assess the independent and combined contribution of material, psychosocial, behavioural and biomedical factors to the explanation of socio-economic (education and income) inequalities in mortality.

DATA AND METHODS

The Nord-Trøndelag Health Study (HUNT 2, 1995-97) is based on a cross-sectional survey of a county population in middle Norway (www.hunt.ntnu.no) with linked mortality data from a 7 year follow up period. All inhabitants of the county aged 20 years or more were invited to participate (71 % of the adult population participated). In the age range 24-80 years, 59039 persons were eligible for our analysis. From this sample, persons with missing information on

education or income (men, n=1223, women, n = 1705) were excluded. In order to control for the above mentioned reversed causation (sick people might change their behaviour (such as physical activity), weight, become unemployed etc.), persons having a history of any of the following diseases were also excluded from the analysis (men: n=8471, women, n=11.115): cardiovascular diseases (including angina pectoris, myocardial infarction, stroke, and hypertension), musculoskeletal diseases (including ankylosing spondylitis, osteoarthritis, rheumatid arthritis, and osteoporosis), thyorid diseases (including hypothyroidism, goiter, and hyperthyroidism), cancer, asthma and diabetes. Finally, 18 247 men and 18 278 women were subject to our analysis. The sample was linked to the national death registry, which provides a follow-up until the end of year 2003, and to data on income from Statistics Norway. The data linkage was provided and administrated by Statistics Norway, on the basis of a unique "personal identity number".

Socioeconomic variables

The original educational variable in HUNT 2 [13] was reclassified into three levels of the highest educational level achieved - primary (up to 10 years education), secondary (up to 12 years education), and tertiary (at least 13 years), which is the reference category.

The income variable stems from the tax registry data on individual pension-qualifying income in 1995. Income quartiles were created separately for men and women, based on income distribution in the whole HUNT 2 survey, as the income distribution was dissimilar between sexes. People with no pensionable income were included in the I. quartile category. The quartile with the highest income was used as a reference category (quartile IV).

Material, psychosocial, behavioural and biomedical factors

The group of material factors included an indicator of employment status (in labour force, unemployed, retired, in military service/education process), receipt of any public benefit (dichotomised: yes – no) and a question on perceived financial difficulties (dichotomised: often – now and again / rarely).

Data describing psychosocial factors included indicators of civil status (married, single, divorced/separated, widowed), number of good friends (dichotomised: 0-1 good friend, >1), participation in club activities (dichotomised: less or more than 1 times per month) and self esteem (dichotomised: 0-9 points or higher score). Symptoms of anxiety and depression were measured by 14 four-point Likert-scaled items, 7 for anxiety (HADS-A) and 7 for depression (HADS-D) [14]. Scores of these scales were dichotomised with cut-off levels >=8 for anxiety and the same for depression.

Behavioural factors were measured by information about smoking (more or less than 20 cigarettes per day, being a former smoker, never smoked), alcohol consumption (moderate: 1-14 drinks in 2 weeks, excessive: >14 drinks in 2 weeks, abstinent), and caffeine consumption (<7 cups of coffee a day, excessive: >= 7 cups a day). Physical activity measured in two questions was scored with number of hours per week spent on activity type - hard physical activity was given twice as much weight as slight physical activity (inactive 0-1 hours per week, moderately active 2-5 hours a week, active 6-9 hours per week). Missing information on either hard or slight physical activity was replaced by the modus value typical for persons who performed the same amount of non-missing activity.

Known biomedical factors included BMI measure in three categories (<20, 20-30, >= 30), dichotomised measures of glucose (higher or lower than 8.0), waist (higher or lower than 102

cm), waist-to-hip ratio (higher or lower than 0.91), triglycerides (higher or lower than 2.25), HDL cholesterol (higher or lower than 0.9). Hypertension was defined as having systolic blood pressure higher than 140 and/or diastolic blood pressure higher than 90. High cholesterol category is represented by values higher than 6.9, low cholesterol by values lower than 4.7, range 4.7 – 6.9 was used as a reference category.

A sensitivity analysis with continuous variables instead of dummy variables where eligible, resulted in similar estimates, with a higher potential of gradient explanation with dummy variables. By means of dummy variable adjustment we also checked whether exclusion of missing categories from the analysis would affect the results, and it was not the case.

Statistical analyses

Age adjusted hazard ratios for levels of education and income, respectively, were calculated by Cox regression models separately for men and women, since there was an income-gender interaction. Although there was no interaction between gender and education, we also conducted separate analysis of education by gender for reasons of consistency. Explanatory factors with a risk of mortality not including the HR 1.00 were selected for further analyses. The reference model consists of hazard ratios for mortality adjusted for age only. Further models were adjusted for material, behavioural, psychosocial, and biomedical factors separately, further adjusted for combinations of two factors, then adjusted for three factors and finally adjusted for all explanatory factors simultaneously. For each regression model, the percentage change in hazard ratios of each level of education and income, respectively, was calculated. (100 x (HR reference model – HR explanatory factors) / (HR reference model -1). The independent effect of an explanatory factor was assessed by subtracting the percentage reduction of hazard ratios of a model without this factor from a model including this factor.

The indirect effect of an explanatory factor (the overlap between two factors) was calculated by subtraction of the independent contribution of the explanatory factor from the total contribution of this factor[8].

RESULTS

Tables 1a and 1b show the associations between education, income and mortality for men and women. Since there was no income or educational gradient in mortality amongst women, we restricted further analysis to men only and computed hazard ratios of mortality by explanatory factors. Causes of death in men included ischemic heart disease (121), stroke (49), other circulatory diseases (92), lung cancer (54), prostate cancer (27), other cancer (190), accidents and violent causes (64), respiratory (21) and other and unknown causes of death (89). All behavioural and psychosocial factors were associated with mortality. In known biomedical factors, triglycerides and HDL cholesterol measures were not associated with mortality, neither were financial difficulties in the group of material factors (Table 2). These factors were excluded from further analyses. In table 3, age standardized baseline prevalence of high-risk categories in explanatory factors are presented, by educational and income level, respectively. Risk factors were more prevalent in lower educated groups and in lower income categories.

---- TABLE 1 HERE ----

---- TABLE 2 HERE ----

---- TABLE 3 HERE ----

Educational inequalities in mortality

The relative risk of mortality was considerably higher in lower educated groups in comparison to the group with highest education (model 1, table 4a). This risk was attenuated when adjusted for different groups of explanatory factors. Adjustment for psychosocial factors (model 4, Table 4a) and behavioural factors (model 3) lowered the hazard ratios most (29 to 37%), followed by material (model 2) and biomedical factors (model 5). Adjustment for behavioural factors in addition to psychosocial factors (model 9, Table 4a) lowered the risk of mortality by 51 and 60 %. The independent contribution of behavioural factors in relation to psychosocial factors was higher than that of biomedical factors (17- 24 % versus 3-10 %). The large independent effect of psychosocial factors accompanied by similarly large independent effect of behavioural factors is illustrated in Fig. 2. Inclusion of material and biomedical factors further decreased the hazard ratios - that implicates that all groups of factors independently contributed to the explanation of educational inequalities.

--- TABLE 4A HERE ---

--- TABLE 4B HERE ---

Income inequalities in mortality

In income, the risk of mortality was higher in lower income groups in comparison to the highest quartile (but not in the second highest quartile) (model 1, Table 4b). The largest proportional decrease in hazard ratios when adjusted for explanatory factors was accounted for by material factors (11 to 52 %) (model 2, table 4b), followed by psychosocial, behavioural and biomedical factors. Further adjustment for psychosocial factors in addition to material factors lowered the hazard ratios by another 23 % (model 6, table 4b) (Fig. 2). The

independent contribution of psychosocial factors was also higher than that of behavioural factors. Adjustment for all factors further reduced the hazard ratios.

DISCUSSION

Our results suggest that material factors are most important in explaining income inequalities in men's mortality, while psychosocial and behavioural factors are more important in the explanation of educational inequalities. Our findings are in contrast to those from the van Oort et al. study [8] and the study from Schrijvers et al. [7], where material factors represented the most important explanation of educational inequalities in mortality in the Netherlands. An unexpected finding was that subjective perceptions of financial difficulties were not associated with the risk of mortality in our sample. Inclusion of other factors such as material assets or house tenure to material factors might have resulted in higher contribution of material factors to the explanation of educational inequalities.

We found no evidence for an association between education, income and mortality during seven years follow-up of a group of Norwegian women (with no history of a serious disease at baseline). Socioeconomic inequalities in women in Norway and other Western European countries are generally smaller than among men, but usually still having a meaningful magnitude. Other studies have suggested that in Norway educational and income inequalities in women's mortality have even increased during recent years [1 15]. However, a HUNT based study on self reported morbidity found a trend of decreasing educational inequalities for both men and women in the Nord-Trøndelag county [16]. A sensitivity analysis confirmed that our finding can be explained by the exclusion of people with a history of serious disease and a higher prevalence of diseases in lower SE groups in women. Musculosceletal disorders and thyroid diseases were more prevalent in women, however their exclusion did no affect the

size of SE differences in women. The non-existent gradient among women in our study can also be partly explained by a different pattern of causes of death. In our selected sample of women, cause of death by cancer was more prevalent than cardiovascular causes of death, whereas in the original sample, cardiovascular causes of death were most prevalent. Commonly, cancer mortality is known to show smaller SE differences than cardiovascular diseases [1]. In addition, the relatively short follow-up period implies that we have observed mortality from conditions with rather short survival periods. The prevalence of mediating factors in women according to education and income levels was also less unequally distributed than among men.

Our findings for men are in line with life course theories, which suggest that different aspects of social inequalities in health can be explained by different pathways[17]. While the (neo)material pathway (focusing on material disadvantages) seems to be most valid explanation for income inequalities in mortality, our results implicate that pathways resulting from educational attainment are different. Education, which shapes one's life in young adulthood, seems to play an important role in establishing networks and partnership and setting a normative framework for behavioural norms and practices. Material factors like employment status and receipt of public benefits as indicators of financial situation and current living status represent a straightforward explanation of income inequalities in mortality, but probably point out to a life long accumulation of disadvantages [18]. Low paid persons are more prone to unemployment[19] and public benefits receipt; while being employed might provide additional material benefits. Nonetheless, employment status and social benefits might also be interpreted in terms of health selection, and the reverse causal direction to income can not be totally disregarded. However, we controlled for the reversed pathway by excluding people with health problems from the analysis.

Psychosocial factors could explain part of the material factors' effect, and they also constituted an independent pathway besides material factors. The relative contribution of material factors seemed to support the (neo)material explanation of income inequalities in mortality [5]. However, psychosocial factors contributed much more than material factors to the explanation of mortality in the third income quartile, which gives support to the psychosocial interpretation of income inequalities in health [6]. A substantial part of the effect of material factors could not be explained by other factors.

The explanatory role of known biomedical factors was rather modest. Particularly psychosocial factors seem to be more important than known biomedical factors. However, including more, and more comprehensive biomedical factors might yield a higher importance of biomedical factors. Health conditions might be a result of accumulation of biological risks over life course – thus adverse conditions measured over longer time might explain more than current status [20]. The relatively weak mediatory effect of known biomedical factors might have been influenced by the analytical design of the study. Since precursors of adult mortality inequalities might develop early in life[21], or accumulate through the life course[22], exclusion of persons with pre-existing serious illness from the analysis could differentially impact on the most deprived groups with the strongest biomedical markers of health problems established at an earlier stage in life. Biomedical factors available in our study included mostly measures that are more closely related to CVD mortality. Biomedical factors contributed most to the explanation of CVD mortality inequalities, while in cancer mortality their contribution was negligible (results not shown). Further longitudinal studies including more comprehensive information on biomedical factors and studies of cause specific mortality might help to increase our knowledge about this pathway.

The large independent effect of psychosocial factors, which can not be reduced to behavioural nor biomedical explanation, is worth further examination. It implies, that the effect of insufficient social networks can not be boiled down to adverse health behaviours and biomedical conditions, but releases other mechanisms which are directly associated with mortality. Even though more precise measurement of bodily response to adverse psychosocial conditions might become available [12], we suggest that effective prevention would need to focus on the underlying causes.

Limitations

Although our data have some strengths (availability of data for men and women, four major groups of explanatory factors), there are also some limitations. The selection of explanatory factors has several implications for our study. We made a literature-based selection of probably most important items for our four groups of explanatory factors[4 23]. Some of the established mediating factors were not strong predictors for mortality in our study, and were thus excluded, although in other populations, they might play a substantial role in explaining social inequalities. It is possible that inclusion of other factors (such as material, psychosocial and biomedical variables), which were not available in our survey, might have led to slightly different results. Measurement error introduced by selection of variables and measurement accuracy of those variables might have resulted in an underestimation of the contribution of explanatory factors. A study design with repeated measurements over time or with more indicators at one time might yield more precise estimates, and the size of measurement error could be assessed [24].

The decomposition of direct and indirect effect for mediators is based on the assumptions of causal relationship between mediators and outcome, no interaction by the mediators and no

confounding for the exposure-outcome association and mediator-outcome association[25-27]. Potential confounding factors, which were not included in the analysis might have led to unpresice estimation of factors contribution. Our conceptual diagram might not represent the "true" state, but is a tool to analyze associations under a selected set of causal assumptions[28]. Nevertheless, the causal direction from material factors through psychosocial factors on health might also work the other way. Mutual influences in both directions might be most likely. In future research, it is important to examine the causal associations in studies with repeated measurements.

The assumption of downstream effects of mediating variables from socioeconomic exposures is limited by the cross-sectional design of the study. In order to diminish possible reversed causality (sick people might change their behaviour), 35 % of men were excluded from the analysis due to history of disease. Since these diseases are more prevalent in lower SEP groups, a larger group from low SEP has been filtered out. A sensitivity analysis revealead that adjustment for all chronic condition led to smaller SE differences, and a slight overestimation of explanatory factors.

We combined people with no income and the I. income quartile group. Because income data are given only for pensionable earnings (and do not include pensions), retired pensioners without additional incomes fall under the same category as people without income. This resulted in slightly higher mortality estimates for the lowest income category. In addition, we conducted a sensitivity analysis with household income and with individual income as a continuous measure, which produced similar results as income differences by quartiles..

A sensitivity analysis, from which people who died within the first two years of follow-up were excluded, yielded the same result in respect to educational inequalities, whereas in respect to income inequalities in mortality, a slight increase in the hazard rates for mortality by income quartiles was observed.

The perspective employed in this paper focused on explaining relative inequalities. Biomedical and behavioural factors seem to contribute relatively little to the explanation. However, if we were to focus on absolute inequalities in the population, removing the conventional risk factors would perhaps result in stronger reduction of absolute inequalities[29].

CONCLUSION

Most of the socio-economic inequalities in men could be explained by a combination of psychosocial, material and behavioural factors, whose independent effects persisted after mutual adjustment. This supports the life course explanation of health inequalities - at least for men (Box 1). These results suggest that in order to decrease socio-economic inequalities in mortality amongst men there is a need to focus more on underlying social factors. It might be most efficient to promote social networks, to facilitate employment amongst disadvantaged groups and to facilitate health promoting behaviour. Further longitudinal studies should examine more comprehensively the relative functioning of social and biomedical factors across the life course.

Box 1: Theories of health inequality ([2 18])

Materialist
The (neo)materialist explanation gives primacy to material conditions. It therefore focuses not only on income itself but on what income enables – access to goods and services and exposures to material (physical) risk factors (poor housing, inadequate diet, physical hazards at work, environmental exposures). The neo-materialist approach also focuses on the relationship of public service provision such as schools and transport and welfare to population health.

Behavioural
In a direct behavioural explanation, the link between socio-economic status and health is differences in health related behaviour as a result of adverse personal/psychological characteristics. Social inequalities in health are therefore due to a higher distribution of people with less desirable characteristics in lower socio-economic groups. A more cultural-behavioural explanation suggests that such differences in health behaviour are a consequence of disadvantage and that unhealthy behaviour may be more culturally acceptable amongst lower socio-economic groups.

Psychosocial
Psychosocial explanations focus on how social inequality makes people feel – domination/subordination, superiority/inferiority – and the effects of the biological consequences of these feelings on health. The socio-economic gradient is therefore explained by the unequal social distribution of psychosocial risk factors such as social support, work demands and levels of control, or imbalances in effort-reward.

Biomedical
Biomedical approach provides explanation in terms of unequal prevalence of biological risk factors across different social groups and represents the most proximal link between social characteristics and health condition. It aims to explain how in particular behavioural and psychosocial factors affect body physiological functioning and focuses on pathways leading to chronic diseases as well as on the interplay between genes and environment.

Lifecourse
The lifecourse approach combines aspects of the other explanations, thereby allowing different causal mechanisms and processes to explain the social gradient in different diseases. It also highlights the role of the accumulation of disadvantage over the lifecourse – combining the amount of time different people have spent in more/less disadvantaged circumstances. Health inequality between social groups is therefore a result of inequalities in the accumulation of social, psychological, and biological advantages and disadvantages over time.

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Competing interest statement. The authors have nothing to declare

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Table 1a **Association between education and mortality and income and mortality, 18278 women 24 - 80 years, 1995/97 - 2003**

	No. women	No. deaths	Mean age	Hazard ratio	CI 95%
Education					
Primary education	5622	230	53	1.02	(0.72 – 1.45)
Secondary	8180	79	40	0.95	(0.65 – 1.39)
Tertiary	4476	41	40	1.00	
Income					
I. income quartile	5435	229	49	1.00	(0.68 – 1.47)
II. income quartile	4024	41	41	0.89	(0.57 – 1.37)
III. income quartile	4386	37	41	0.95	(0.61 – 1.47)
IV. income quartile	4433	43	43	1.00	

Note: adjusted for age in 5 year intervals

Table 1b **Association between education and mortality and income and mortality, 18247 men, 1995/97 - 2003**

	24-80 years					24-59 years (15394 men)			60-80 years (2853 men)	
	No. men	No. deaths	Mean age	Hazard ratio	CI 95%	Mortality rate	Hazard ratio	CI 95 %	Mortality rate	Hazard ratio
Education										
Primary education	4803	390	52	**1.67**	(1.29 – 2.15)	113	**1.97**	(1.31-2.95)	280	1.36
Secondary	9255	244	42	**1.35**	(1.04 – 1.75)	83	**1.56**	(1.06-2.30)	241	1.15
Tertiary	4189	74	43	1.00		57	1.00		221	1.00
Income										
I. income quartile	4581	476	52	**2.03**	(1.53 – 2.70)	132	**2.12**	(1.45-3.11)	213	**1.86**
II. income quartile	4362	83	41	**1.44**	(1.05 – 1.98)	94	**1.57**	(1.08-2.29)	302	1.27
III. income quartile	4605	79	43	1.27	(0.92 – 1.75)	84	1.20	(0.82-1.74)	85	1.30
IV. income quartile	4699	70	45	1.00		71	1.00		55	1.00

Note: adjusted for age in 5 year intervals
Age adjusted mortality rate/100 000 person-years was standardized by means of direct standardisation (World standard population)

Table 2 **Age adjusted bivariate impacts (hazard ratios) on mortality of 3 material, 4 behavioural, 6 psychosocial and 8 biomedical factors, controlling first for education (Col. 1) and second for income (Col. 2). Seven years follow-up of men aged 24-80 years**

Material factors	Adjusted for education		Adjusted for income	
	HR	95 % CI	HR	95 % CI
Public benefits				
Any	**1.70**	(1.35 – 2.14)	**1.55**	(1.21 – 1.99)
Missing	**1.32**	(1.05 – 1.66)	1.18	(0.92 – 1.51)
No	1.00		1.00	
Financial difficulties				
Yes	1.24	(0.89 – 1.73)	1.30	(0.73 – 2.33)
Missing	1.05	(0.88 – 1.27)	0.93	(0.77 – 1.13)
No	1.00		1.00	
Employment status				
Unemployed	**2.43**	(1.62 – 3.63)	**2.30**	(1.52 – 3.49)
Retired	**1.71**	(1.37 – 2.14)	**1.51**	(1.17 – 1.94)
Military/education	**3.13**	(1.15 – 8.51)	2.35	(0.85 – 6.50)
Missing	1.38	(0.61 – 3.12)	1.23	(0.54 – 2.81)
Working	1.00		1.00	

Behavioural factors	Adjusted for education		Adjusted for income	
Smoking				
Smoker >= 20 cig.	**3.37**	(2.48 – 4.57)	**3.46**	(2.55 – 4.69)
Smoker < 20 cig.	**1.81**	(1.45 – 2.25)	**1.84**	(1.48 – 2.29)
Former smoker	1.10	(0.89 – 1.36)	1.11	(0.90 – 1.38)
Missing	**1.36**	(1.01 – 1.83)	**1.37**	(1.02 – 1.84)
Never smoker	1.00		1.00	
Physical activity				
Inactive (0-1 h)	**1.86**	(1.47 – 2.36)	**1.90**	(1.50 – 2.41)
Moderately active (2-5 h)	**1.29**	(1.08 – 1.55)	**1.31**	(1.10 – 1.57)
Missing	**1.39**	(1.10 – 1.76)	**1.44**	(1.14 – 1.81)
Active (6-9 h)	1.00		1.00	

Alcohol				
Excessive (>14 drinks in 2 weeks)	**2.48**	(1.80 – 3.43)	**2.27**	(1.65 – 3.13)
Abstinent	**1.19**	(1.00 – 1.42)	1.18	(0.99 – 1.40)
Missing	1.06	(0.84 – 1.34)	1.10	(0.87 – 1.38)
Moderate (1-14 drinks in 2 weeks)	1.00		1.00	
Caffeine				
Excessive caffeine (7 and more cups)	**1.54**	(1.25 – 1.89)	**1.60**	(1.30 – 1.96)
Missing	1.34	(0.87 – 2.08)	1.34	(0.87 – 2.08)
Less than 7 cups	1.00		1.00	

Table 2 continued

Psychosocial factors	Adjusted for education		Adjusted for income	
	HR	95 % CI	HR	95 % CI
Good friends				
0-1 good friend	**1.43**	(1.07 – 1.91)	**1.45**	(1.09 – 1.95)
Missing	1.11	(0.95 – 1.31)	1.16	(0.99 – 1.36)
2 and more friends	1.00		1.00	
Club activity				
Less than 1x per month	**1.26**	(1.06 – 1.50)	**1.31**	(1.10 – 1.55)
Missing	**1.32**	(1.07 – 1.64)	**1.37**	(1.11 – 1.69)
1x per month or more	1.00		1.00	
Anxiety symptoms				
Anxiety >= 8	**1.66**	(1.18 – 2.35)	**1.57**	(1.11 – 2.22)
Missing	1.19	(0.99 – 1.42)	1.18	(0.99 – 1.42)
Anxiety < 8	1.00		1.00	
Depression symptoms				
Depression >=8	**1.74**	(1.41 – 2.15)	**1.71**	(1.38 – 2.11)
Missing	**1.58**	(1.28 – 1.96)	**1.57**	(1.27 – 1.94)
Depression <8	1.00		1.00	
Civil status				
Unmarried	**1.57**	(1.28 – 1.93)	**1.51**	(1.23 – 1.85)
Separated	**1.35**	(1.00 – 1.82)	**1.36**	(1.01 – 1.83)
Widowed	**1.34**	(1.00 – 1.80)	1.29	(0.96 – 1.73)
Missing	2.56	(0.64 – 10.3)	2.43	(0.61 – 9.74)
Married	1.00		1.00	
Self esteem				
Low 10-16	**1.76**	(1.24 – 2.50)	**1.72**	(1.21 – 2.44)
Missing	1.08	(0.91 – 1.28)	1.10	(0.93 – 1.29)
Fine 0-9	1.00		1.00	

Table 2 continued

Biomedical factors	Adjusted for education		Adjusted for income	
	HR	95 % CI	HR	95 % CI
BMI				
BMI < 20	**2.15**	(1.40 – 3.31)	**2.07**	(1.35 – 3.17)
BMI >= 30	**1.31**	(1.07 – 1.62)	**1.34**	(1.09 – 1.65)
Missing	**4.67**	(2.32 – 9.40)	**4.21**	(2.09 – 8.47)
BMI 20-29.9	1.00		1.00	
Hypertension				
Sys >140 or dias > 90	**1.30**	(1.11 – 1.54)	**1.32**	(1.12 – 1.56)
Sys <=140 or dias <= 90	1.00		1.00	
Glucose				
Glucose >8.0	**1.79**	(1.32 – 2.43)	**1.84**	(1.36 – 2.50)
Missing	1.62	(0.23 – 11.5)	1.69	(0.24 – 12.0)
Glucose <=8.0	1.00		1.00	
Cholesterol				
Cholesterol <4.7	**1.48**	(1.14 – 1.94)	**1.42**	(1.08 – 1.85)
Cholesterol >6.9	**1.20**	(1.01 – 1.44)	**1.21**	(1.01 – 1.44)
Missing	1.69	(0.24 – 12.0)	1.76	(0.25 – 12.5)
Cholesterol 4.7-6.9	1.00		1.00	
Waist				
Waist > 102 cm	**1.53**	(1.26 – 1.86)	**1.54**	(1.27 – 1.88)
Missing	**2.94**	(1.39 – 6.20)	**2.66**	(1.26 – 5.61)
Waist <=102	1.00		1.00	
Waist-to-hip ratio				
Ratio > 0.91	**1.17**	(1.01 – 1.36)	**1.18**	(1.02 – 1.38)
Missing	**2.60**	(1.23 – 5.50)	**2.40**	(1.13 – 5.08)
Ratio <=0.91	1.00		1.00	
Triglycerides				
Tg >2.25	0.88	(0.74 – 1.04)	0.88	(0.74 – 1.04)
Missing	1.52	(0.21 – 10.8)	1.59	(0.22 – 11.3)
Tg<=2.25	1.00		1.00	
HDL cholesterol				
HDL<0.9	1.15	(0.94 – 1.40)	1.14	(0.94 – 1.39)
Missing	1.51	(0.21 – 10.8)	1.60	(0.23– 11.4)
HDL>=0.9	1.00		1.00	

Note: Adjusted for age in 5 year intervals

Table 3 Age standardized baseline prevalence proportion of high-risk categories by educational and income level, respectively, 18247 men

	Primary	Secondary	Tertiary	1.quart.	2.quart.	3.quart.	4.quart
Material factors							
Public benefits							
Any	18	14	9	29	15	7	4
Employment status							
Unemployed	5	3	2	8	5	1	1
Retired	16	10	7	27	3	2	1
Behavioural factors							
Smoking							
Smoker >= 20 cig.	8	6	3	7	5	5	5
Smoker < 20 cig.	31	24	15	26	27	25	18
Physical activity							
Inactive (0-1 h)	17	13	8	14	14	13	10
Moderat. active (2-5 h)	39	40	40	37	40	41	44
Alcohol							
Excessive (>14 drinks)	5	6	7	6	4	5	7
Caffeine							
Excessive (>=7 cups)	21	15	9	16	17	16	14
Psychosocial factors							
Good friends							
0-1 good friend	6	6	6	6	6	6	6
Club activity							
< 1x per month	46	36	27	40	38	37	33
Anxiety symptoms							
Anxiety >= 8	7	5	5	8	5	5	4
Depression symptoms							
Depression >=8	11	8	6	13	9	8	6
Civil status							
Unmarried	34	30	26	40	32	27	23
Separated	8	7	6	7	8	7	7
Widowed	2	2	1	2	1	1	1
Self esteem							
Low 10-16	4	3	3	6	3	3	2
Biomedical factors							
BMI							
BMI < 20	2	1	1	3	1	1	0
BMI>=30	15	12	9	14	11	11	12
Hypertension							
Sys >140 or dias > 90	43	38	33	40	39	37	35
Glucose							
Glucose >8.0	2	2	2	2	2	2	2
Cholesterol							
Cholesterol <4.7	12	15	18	15	16	15	14
Cholesterol >6.9	17	15	11	17	15	14	13
Waist							
Waist > 102 cm	11	8	6	12	7	8	8
Waist-to-hip ratio							
Ratio > 0.91	36	32	26	35	31	30	29

Note: Standardized by direct method

Factors in italics were not included in the analysis because they did not contribute to explanation of the inequalities when adjusted for other factors from the same explanatory group. They did not improve the final models either.

Table 4a Hazard ratios and proportional change for mortality by educational levels in men

Model		Primary education			Secondary education			
		HR	95 % CI	% change	HR	95 % CI	% change	-2LL
1	Age adjusted	1.67	(1.29 – 2.15)		1.35	(1.04 – 1.75)		11770
2	Material	1.54	(1.19 – 2.00)	19	1.28	(0.98 – 1.66)	20	11728
3	Behavioural	1.42	(1.10 – 1.85)	37	1.25	(0.96 – 1.63)	29	11652
4	Psychosocial	1.43	(1.10 – 1.85)	36	1.23	(0.95 – 1.61)	34	11711
5	Biomedical	1.55	(1.20 – 2.01)	18	1.31	(1.01 – 1.70)	11	11698
6	Material + psychosocial	1.35	(1.04 – 1.76)	48	1.19	(0.92 – 1.55)	46	11675
7	Material + behavioural	1.35	(1.03 – 1.75)	48	1.21	(0.93 – 1.57)	40	11618
8	Material + biomedical	1.45	(1.12 – 1.88)	33	1.25	(0.96 – 1.63)	29	11662
9	Psychosocial + behavioural	1.27	(0.97 – 1.66)	60	1.17	(0.90 – 1.53)	51	11604
10	Behavioural + biomedical	1.36	(1.04 – 1.77)	46	1.22	(0.94 – 1.60)	37	11589
11	Psychosocial + biomedical	1.36	(1.04 – 1.77)	46	1.22	(0.93 – 1.58)	37	11646
12	Material + psychosocial + behavioural	1.22	(0.93 – 1.60)	67	1.15	(0.88 – 1.50)	57	11575
13	All	1.18	(0.90 – 1.55)	73	1.14	(0.87 – 1.49)	60	11521

Note: Tertiary education is the reference category
Adjusted for age in 5 year intervals
All nested models were significantly improved

Table 4b Hazard ratios and proportional change for mortality by income quartiles, men

Model		I. quartile			II. quartile			III. quartile			
		HR	95 % CI	% change	HR	95 % CI	% change	HR	95 % CI	% change	-2LL
1	Age adjusted	2.03	(1.57 – 2.70)		1.44	(1.05 – 1.98)		1.27	(0.92 – 1.75)		11760
2	Material	1.49	(1.08 – 2.07)	52	1.27	(0.92 – 1.76)	39	1.24	(0.90 – 1.72)	11	11735
3	Behavioural	1.84	(1.35 – 2.46)	18	1.35	(0.98 – 1.87)	20	1.24	(0.90 – 1.72)	11	11640
4	Psychosocial	1.68	(1.26 – 2.25)	34	1.30	(0.95 – 1.80)	32	1.20	(0.87 – 1.66)	29	11705
5	Biomedical	1.87	(1.40 – 2.49)	16	1.39	(1.01 – 1.91)	11	1.26	(0.91 – 1.74)	4	11688
6	Material + psychosocial	1.26	(0.90 – 1.76)	75	1.17	(0.84 – 1.62)	61	1.18	(0.85 – 1.63)	33	11679
7	Material + behavioural	1.38	(0.99 – 1.91)	63	1.22	(0.88 – 1.68)	50	1.22	(0.88 – 1.68)	19	11616
8	Material + biomedical	1.40	(1.01 – 1.95)	61	1.24	(0.89 – 1.71)	45	1.23	(0.89 – 1.70)	15	11667
9	Psychosocial + behavioural	1.57	(1.17 – 2.10)	45	1.25	(0.91 – 1.73)	43	1.19	(0.86 – 1.65)	30	11595
10	Behavioural + biomedical	1.73	(1.30 – 2.31)	29	1.32	(0.96 – 1.82)	27	1.24	(0.90 – 1.71)	11	11578
11	Psychosocial + biomedical	1.59	(1.19 – 2.13)	43	1.28	(0.93 – 1.76)	36	1.20	(0.87 – 1.65)	29	11642
12	Material + psychosocial + behavioural	1.19	(0.85 – 1.66)	82	1.13	(0.81 – 1.57)	70	1.17	(0.85 – 1.62)	37	11574
13	All	1.17	(0.83 – 1.63)	83	1.12	(0.80 – 1.55)	73	1.18	(0.85 – 1.63)	33	11520

Note: IV. income quartile (the highest income) is the reference category
Adjusted for age in 5 year intervals
All nested models were significantly improved